

Research Article

Comparison of Locking Compression Plate and Dynamic Compression Plate with Cancellous Bone Graft in Treating Non-Union of Humeral Shaft Fractures

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Abstract

Background: Treatment of humeral shaft fractures varies from conservative modalities to operative fixation. There are noticeable high non-unions in humeral shaft fractures. Locking compression plates are now preferred over dynamic compression plates in the treatment of such cases along with cancellous bone graft. There was no randomized controlled trial comparing locking versus dynamic compression plates in the treatment of non-union of humeral shaft fractures.

Objective: To compare functional outcome of locking compression plate and dynamic compression plate with cancellous bone graft in treating humeral shaft non-unions.

Methods: It was a randomized controlled trial conducted at the Department of Orthopedic Surgery, Mayo Hospital, Lahore. The sample size of this study was 150 patients with non-union of humeral shaft fractures. These patients were randomly divided into two treatment groups. Group-A underwent locking compression plate (LCP) with cancellous bone graft and Group-B underwent dynamic compression plate (DCP) with cancellous bone graft.

Results: The mean age of the patients was 40.00±12.30 years in Group-A and 38.73±13.06 years in Group-B (p=.542). Functional outcome was significantly better with DCP with cancellous bone graft as compared to LCP with cancellous bone graft in all age groups (p≤.004), genders (p≤.012), educational (p≤.049) and economic status (p≤.003) and BMI (p≤0.049) based on Modified Constant & Murley score.

Conclusion: Function outcome is significantly better with dynamic compression plate as compared to locking compression plate with cancellous bone graft in patients with non-union of fractures of shaft of humerus.

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Introduction

The treatment of fractures of humeral shaft varies, ranging from conservative treatment to operative fixation like plate osteosynthesis or intramedullary fixation. Nonunion is a complication of both; conservative and operative interventions.¹ The

frequency of nonunion is estimated to be 1.1% to 10% following operative treatment of proximal humerus fracture and 5.5% following treatment of humeral Shaft fracture.¹ While reported union rates with conservative management are >90% in most studies.³

Non-union of the humerus result in significant morbi-

dity, requiring numerous operative procedures to treat and may leave the patient with functional deficits.^{1,4} Such cases of non-union can present particular challenges in management like mal-alignment, infection and soft tissue compromises. Currently the available literature regarding long-term outcomes and treatment guidelines for non-union of humeral fractures is very limited.⁴

Locking plates and dynamic compression plates are now considered as a better option to treat the non-unions of humeral shaft fracture.^{5,7} A recently conducted study to evaluate the outcome of treatment of aseptic nonunion of the humeral shaft with a dynamic compression plate and cancellous bone graft. Using the modified Constant and Murley Score it reported 79% excellent while 21% good results and there was no patient with fair or poor score.⁶ A separate study reported outcome of Locking compression plate with cancellous bone graft in non-union humeral shaft fractures using modified Constant and Murley score, that showed excellent results in 11(45.83%), good in 10(41.67%), fair in 2(8.33%) and poor outcome in 1 (4.17%) patient. Complications included delayed union in 2(8.33%), transient Radial nerve palsy in 2(8.33%) and persistence of nonunion in 1(4.1%).⁸ LCP are the latest device. They are used for non-union due to large screw holes and in osteoporotic bone for stability.^{9,10}

The rationale of this study was to compare outcome of Locking compression plate and dynamic compression plate with cancellous bone graft in treating humeral shaft non-unions using modified Constant and Murley score. According to our knowledge no recorded trial both locally and internationally have been found in which both fixation methods are compared, or both methods are compared for a single population from a single author using Modified Constant and Murley score. Hence, this study will give us evidence about the better fixation option for treatment of humeral shaft nonunion.

Methodology

It was a Randomized Controlled Trial (RCT) conducted at The Department of Orthopedic Surgery, Mayo Hospital, Lahore for a period of 36 months from 14/10/2012 to 13/10/2015. A total of 150 patients (75 in each group) were included in this study. Patients

were selected by simple random sampling technique and randomization was done by computer allocation method. Patients of age 18 to 60 years of either sex with nonunion humeral shaft with previous surgical intervention or non-surgical treatment and agreeing to long follow-up were included in the study. Patients with more than one fracture and/or metabolic bone disease evident on x-rays, with skeletal dystrophy or congenital anomaly and malignant bone disease were not included. Patient's biodata like name, age, sex and contact details were noted after informed consent. Patients were randomly divided into two groups using lottery method. Patients in Group-A were treated with locking compression plate with cancellous bone graft while Group-B patients were treated with dynamic compression plate with cancellous bone graft.

After approval from the institutional review board, we took informed written consent. Surgical procedure was explained to patients and attendants before surgery according to their surgical group. All the patients were clinically assessed prior to any fixation. Patients in both groups were operated using anterior approach. All patients were given injection ceftriaxone 1gm half an hour before surgery and 2gm, 24 hourly for three days post-operatively. Later they were given oral antibiotic for seven days. Surgeries were done under general anesthesia by the same surgical team to avoid any bias. In both groups all patients were followed up for functional outcome at 3rd, 6th, 9th and 12th weeks post-operatively. All the data were collected on a pre-designed proforma. Data was analyzed using SPSS version 20.

Numerical variables like age and Modified Constant and Murley score (0-100) have been presented by mean \pm SD. "independent sample t test" has been applied to compare the Modified Constant and Murley score¹¹ between the two groups taking p-value ≤ 0.05 as significant. Categorical variables i.e. gender and functional outcome (Moderate, good or excellent) using modified Constant and Murley Score have been presented in terms of frequency or percentage at every follow-up. Chi-Square test has been applied to compare functional outcome (Moderate, good or excellent) in both the study groups while taking p-value ≤ 0.05 as significant.

Patient was in supine position, after general anesthe-

sia, a curved skin incision midway between deltoid origin and insertion in line with lateral border of the bicep muscle with 7.5cm of the elbow was made. Superficial dissection was completed, and cephalic vein was retracted medially. Radial nerve was explored and mobilized distally till lateral intermuscular septum and retracted with sling. Proximally the deltoid was retracted laterally and bicep muscle medially to expose the shaft. Brachialis muscle was split in the line of fibers and retracted subperiosteally an lateral half to the lateral side and medial half to the medial side by flexing the elbow. Bone ends were trimmed till they started bleeding. Fracture reduced under vision and fixation with 4.5mm locking plate with screw or 4.5mm broad dynamic compression screw was fixed with four holes proximal and distally. Bone graft was taken from iliac crest was placed at fracture site. Wound washed, drain placed and closed in layer. Dressing was done.¹²

Result

This study involved 150 patients with fracture non-union of shaft of humerus. Age of the patients ranged from 18 to 60 years with a mean of 39.37 ± 12.66 years. The mean age of the patients was 40.00 ± 12.30 years in Group-A and 38.73 ± 13.06 years in Group-B ($p=.542$). Majority 70% patients were male and 30% were female. In Group-A, 66.7% patients were male with 33.3% females while in Group-B, 73.3% were male and 26.7% were female.

In study Group-A 30.7% patients were illiterate, 53.3% were matric, 9.3% were intermediate and 6.7% patients were graduate. In Group-B, these frequencies were 26.7%, 46.7%, 20.0% and 6.7% respectively. In Group-A, 10.7% patients belonged to poor class with 74.7% in lower middle and 13.3% in upper middle class while only 1.3% patients belonged to upper class. In Group-B, 13.3% patients belonged

to poor class with 70.7% in low middle and 14.7% in upper middle class while only 1.3% patients belonged to upper class. The mean body mass index (BMI) of the patients was not significantly different between the groups with a p-value of .870.

The mean Modified Constant & Murley score was 74.37 ± 9.22 , 77.43 ± 9.39 , 81.17 ± 9.21 and 85.34 ± 8.97 at 3, 6, 9 and 12 post-operative weeks respectively. The mean Modified Constant & Murley score was significantly higher in Group-B as compared to Group-A at 3, 6, 9 and 12 weeks post-operatively as shown in Table-1.

Functional Outcome was significantly better in Group-B as compared to Group-A; Excellent, Good, Moderate at 3, 6, 9 and 12 weeks post-operatively as shown in Table-2.

Functional outcome was significantly better with DCP with cancellous bone graft as compared to LCP with cancellous bone graft in all age groups ($p \leq .004$), genders ($p \leq .012$), educational ($p \leq .049$) and economic status ($p \leq .003$) and BMI ($p \leq .049$) using chi square test.

Discussion

Non-operative treatment of simple humeral shaft fractures is a very valid option, with good results in most cases.^{13,14,16,17} Although complications are infrequent, non-operative treatment usually requires a prolonged period of cast immobilization, which carries a risk of shoulder joint stiffness that may be very inconvenient for the patient.^{15,19} Moreover, nonunion after conservative treatment of humeral shaft fractures does occur in up to 10% of the cases and treatment of this complication can be extremely difficult.^{17,20}

Non-union of the humeral shaft fractures result in

Table 1: Comparison of Mean Modified Constant and Murley Score between the Two Study Groups

	Study Group	N	Mean	Std. Deviation	Std. Error Mean	P value
Modified Constant & Murley Score at 3 Weeks	Group-A	75	71.47	10.526	1.215	<0.001
	Group-B	75	77.27	6.581	.760	
Modified Constant & Murley Score at 6 Weeks	Group-A	75	74.20	10.875	1.256	<0.001
	Group-B	75	80.67	6.159	.711	
Modified Constant & Murley Score at 9 Weeks	Group-A	75	77.93	10.555	1.219	<0.001
	Group-B	75	84.40	6.193	.715	
Modified Constant & Murley Score at 12 Weeks	Group-A	75	81.76	9.857	1.138	<0.001
	Group-B	75	88.92	6.236	.720	

Table 2: Comparison of Functional Outcome between the Two Study Groups

			Functional Outcome at 3 Weeks			Total	P value
			Moderate	Good	Excellent		
Study Group	Group-A	Count	40	35	0	75	<0.001
		% within Study Group	53.3%	46.7%	.0%	100.0%	
	Group-B	Count	15	50	10	75	
		% within Study Group	20.0%	66.7%	13.3%	100.0%	
Total		Count	55	85	10	150	
		% within Study Group	36.7%	56.7%	6.7%	100.0%	
			Functional Outcome at 6 Weeks			Total	P value
			Moderate	Good	Excellent		
Study Group	Group-A	Count	30	35	10	75	<0.001
		% within Study Group	40.0%	46.7%	13.3%	100.0%	
	Group-B	Count	5	45	25	75	
		% within Study Group	6.7%	60.0%	33.3%	100.0%	
Total		Count	35	80	35	150	
		% within Study Group	23.3%	53.3%	23.3%	100.0%	
			Functional Outcome at 9 Weeks			Total	P value
			Moderate	Good	Excellent		
Study Group	Group-A	Count	25	20	30	75	<.001
		% within Study Group	33.3%	26.7%	40.0%	100.0%	
	Group-B	Count	0	30	45	75	
		% within Study Group	.0%	40.0%	60.0%	100.0%	
Total		Count	25	50	75	150	
		% within Study Group	16.7%	33.3%	50.0%	100.0%	
			Functional Outcome at 12 Weeks			Total	P value
			Moderate	Good	Excellent		
Study Group	Group-A	Count	9	31	35	75	<0.001
		% within Study Group	12.0%	41.3%	46.7%	100.0%	
	Group-B	Count	0	16	59	75	
		% within Study Group	.0%	21.3%	78.7%	100.0%	
Total		Count	9	47	94	150	
		% within Study Group	6.0%	31.3%	62.7%	100.0%	

significant morbidity, requiring number of operative procedures to treat and the patient may end up with functional deficits^{1,4} Such cases of non-union humeral shaft fractures can present a lot of challenges in management including mal-alignment, infection and soft tissue compromises. Currently, literature regarding long-term outcomes and guidelines for treatment of non-union of humeral fractures is scanty.⁽⁴⁾ There is increasing interest in treating even simple humeral shaft fractures by dynamic compression plate or locking compression plate in order to avoid these problems and to allow early mobilization and quicker return to work.^{18,19}

Osteosynthesis using dynamic compression plate for humeral shaft fractures, popularized by the Arbeitsgemeinschaft für Osteosynthesefragen (AO) foundation in the 1960s, replaced Intra-medullary (IM)

nauling in many countries and gave promising clinical outcomes.¹⁶ Locking compression plates and dynamic compression plates are now considered a better option to treat the nonunion of humeral shafts.⁽⁵⁾ Lin et al. in 2009 reported 79% excellent and 21% good results with DCP using Modified Constant and Murley Score.⁶ Kumar et al. in 2013 demonstrated excellent results in 11 (45.83%), good in 10 (41.67%), fair in 2 (8.33%) and poor outcome in 1 (4.17%) patient after Locking Compression Plate.⁸ However at the moment, there is no randomized controlled trial(RCT) to compare the outcome of locking versus dynamic compression plate in the treatment of non-union of humeral shaft fractures. Govindasamy R et al. (2016)²¹ in his study of treated 18 cases of non-unions shaft of humerus reported functional outcomes with constant Murley score as excellent in 14, good in 3 and fair in one patient.

Moradiya N et al. (2017)²² treated humeral shaft fractures with DCP. The mean age of the patients was 37.93-year. The mean age of the patients in this study was 40.00±12.30 years in Group-A and 38.73±13.06 years in Group-B (p=.542). Ayotunde OA et al. (2012)²³ treated non unions of humeral fracture with DCP and cancellous bone graft reported that median age of the patients was 41.5 years with range of 23 to 76 years and male to female ratio of 1.8:1. In Group-A, 66.7% patients were male with 33.3% females while in Group-B, 73.3% were male and 26.7% were female (p=.476). The mean Modified Constant & Murley score was significantly higher in Group-B as compared to Group-A. Our results at 12th post-operative week, match with those of Lin et al. (2009) for DCP and Kumar et al. (2013) for LCP.^{6,8} The functional outcome was significantly better with DCP with cancellous bone graft as compared to LCP with cancellous bone graft in all age groups (p≤.004), genders (p≤.012), educational (p≤.049) and economic status (p≤.003) and BMI (p≤.049). Singh SKK et al. 2017⁽²⁴⁾ in his study of fixing log bone with LCP reported that effectiveness of LCP is simple fracture is not proved over conventional plates.

This study is first of its kind and compares functional outcome between DCP versus LCP with cancellous bone graft in the treatment of non-united fractures of humeral shaft. A key limitation of this study is that we only considered functional outcome and other important aspects of management like operating time, post-operative pain, length of stay, post-operative infection and cost were ignored which are however important and need to be considered as well before preferring DCP over LCP. Future randomized controlled trials considering these aspects of treatment are therefore recommended.

Conclusion

Function outcome is significantly better with Dynamic compression plate as compared to Locking compression plate with cancellous bone graft in patients with non-union of humerus shaft fractures.

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